v. Beam Profile Monitor

Although several options of equivalent cost will be explored, the baseline design will be a rotating wire device similar to what is used in the CERN SPS.[1] High scanning speed is required to minimize the heating of the wire. For a 25 µm carbon filament the temperature rise ΔT can be written as[1,2]

$$\Delta T \; = \; 3.8 \times 10^{-22} \; \frac{cal}{MeV} \; \frac{N \; (dE/dx) \; f \; Z^2}{v \; h_{eff} \; S}$$

where N is the number of particles, $dE/dx = 1.78$ MeV/gcm^{-2} is the specific energy loss, $S = 0.45$ cal/g^{o}C is the specific heat of carbon, f is the rotation frequency, v the wire velocity, and $h_{eff} = \sqrt{2\pi}\,\sigma$. If we put $N = 2 \times 10^{13}$, $Z = 1$ (protons) which at 250 GeV/c will have a $\sigma = 0.6$ mm or $h_{eff} = 1.5 \times 10^{-3}$ m and take $v = 5$ m/sec then $\Delta T = 3126$ ^{o}C since $f = 78$ kHz. This is considered a tolerable value and could be exceeded by perhaps a factor of two. However when we consider gold ($Z = 79$) where $\sigma = 0.9$ mm ($\beta = 50$ m) at 100 GeV/u, then we find that only 5×10^9 particles are required to produce the same ~ 3200 ^{o}C rise. Increasing v would of course raise the limit but reduce the resolution i.e. at 5 m/sec and 78 kHz the wire moves 0.064 mm/turn which for the proton beam with a $\sigma = 0.6$ mm is satisfactory. Thus a factor of ten in v (if possible) would permit scanning the nominal intensity in 50 gold bunches but at the expense of a resolution comparable to σ. Thus a wire scanner suitable for intense gold beams would depend upon future developments.

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[1] J. Bosser et al, Nucl. Instr. Meth., A234, 475 (1985).
[2] J. Bosser et al, Proc. 1987 IEEE Particle Accelerator Conference, Vol. 2, p. 783.